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THE CLIFF-DWELLER AND HIS HABITAT

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INTRODUCTION.—In the extreme southwestern part of Colorado on the borderland of the plateau section of the Southwest and of the Rocky Mountains is the highly dissected region, somewhat indefinitely set off by deep canyons and steep escarpments, known as the Mesa Verde. Due to its elevation, greater than the surrounding territory, and to its nearness to the Rocky Mountains, this mesa gets considerably more rain than other near-by regions to the south and west. Due to its greater rainfall it has more of a vegetal covering than one is accustomed to see upon the plateaus, setting it off rather sharply from the rest of the region. The contrast between the yellows and browns and dull reds of the rock outcrops of adjacent parts of the plateau, and the dark greens of the scrub oaks and pinyon trees growing on the mesa must have given the early explorers the suggestion for the name of Mesa Verde, green tableland. (Fig. 1.) In contrast, however, with the still greater greenness of the foothills of the Rockies near-by, the name does not seem well chosen, for the vegetation is sparse and distinctly of the xerophytic type. Instead of a well-watered tableland as the name would suggest, the aridity of the region is the striking feature for one who has come to it from more humid sections. In fact, the mesa may be considered as the beginning of the great American desert of the Southwest.

A part of this region was set aside by an act of Congress, June 29, 1906, as the Mesa Verde National Park "for the preservation and perpetuation of the ruins and other works and relics of prehistoric and primitive man" which are found here on such an extensive scale and in such a comparatively good state of preservation. The park as originally outlined embraced an area of 66.2 square miles, or 42,376 acres. However, after a resurvey to determine its exact boundary limits, it was found that the major ruins for which the park had been

been abandoned long before white man ever visited the region.² They left no writings and what is known of them has been pieced together bit by bit through the efforts of a host of tireless workers in various fields of endeavor. Although the ruins may have been seen by white men before, yet early in 1874 W. H. Jackson, on the Hayden Geological Survey, saw the ruins and was the first to describe them and make the world acquainted with these marvelous structures.³

As might be expected, a great deal that is wild and highly fantastic has found its way into print relative to these people. Although much still remains a mystery, enough is known to dispel the once prevalent idea that the builders of these many roomed structures, whose ruins are now the main mute evidences of their industry and skill, were a strange and unknown race of people. It is now no longer a controversial subject that the Cliff-dweller, the Pueblo Indian, the Mound-builder, and the roving Indian of the plains or woodlands of both continents, were all of one and the same stock. The Cliff-dweller, like others, was originally a nomadic Indian who took up a sedentary life when conditions were sufficiently favorable, and whose development in consequence was modified considerably and in certain respects elevated by the altered conditions of his life. He was an Indian like other Indians; only the natural conditions made him modify his habits of life and his world outlook.⁴ The story of the Mound-builders is similar; they also became sedentary, living in structures made of small logs and grouped in villages. Many of the mounds, however, have been constructed in historic times and articles of European manufacture have been found deep within them.⁵

² The first account of the conditions of the Southwest dates back to 1537, when Fray Marcos de Niza, with his negro, Eetevan, discovered the Zuni Pueblos, believing them to be the famed "Seven Cities of Cibola." The negro, who had been sent ahead to reconnoitre, was killed, and Niza, hastening home, gave glowing accounts of what he had seen, or rather of what he had not seen; but he said nothing of cliff dwellings. In the year 1640 Coronado began his famous exploration tour with a force of three hundred Spaniards and eight hundred Indians in search of the fabled "Quivira." Instead of golden vessels and the wealth of centuries of accumulations, he found only such things as could be used by a poor agricultural people living in stone or adobe houses, dressed in the rudest kinds of cloth, and skilled only in the most simple arts. His narrative has been found remarkably accurate, representing the country and the people as they really were; yet he made no mention of people dwelling in high cliffs or even of ruins. This, however, is not strange for he had seen more marvelous things in Mexico, and furthermore, was only interested in dwellings with possibilities of gold. The belief, however, that the cliff dwellings were abandoned in pre-Spanish times is based chiefly on the fact that no article of European manufacture has ever been found in any of them.

³ Rept. of U. S. Geol. Sur. Terr. for 1874, Ancient Ruins in Southwestern Colorado.

⁴ Baron Nordenskiold, *The Cliff-dwellers of the Mesa Verde* (1893), p. 172.

⁵ For an interesting article see *Archeology in the Southern States* by Henry B. Collins Jr., *Scientific Monthly*, XXII (1923), 322-330.

THE INDIAN'S ADJUSTMENT TO ENVIRONMENT.—The general notion has long been too common that the Indian, wherever found, was a savage, fiendish, and of a low order mentally, and that regions like Peru, Mexico, and our own southwest, necessarily must have been peopled by a race of at least a strain of greater actual potential possibilities in order to have advanced so far beyond those of other regions. It is to be remembered, however, that the Indian with whom the colonists came in contact was of a high order, generous, teaching the newcomer how to do things, and supplying the paleface with the necessities of life more than once and thus keep him from starving. When aroused by injustices and convinced that the white man was his enemy, he became a relentless foe often more than a match for the white man, in spite of an inferior equipment. The Indian had so adapted himself to his environment that he could make a living where the white man could not, and in this respect, at least, was his superior. It must be evident to anyone familiar with Indian studies that had our colonial history been written by the red man, or even by unbiased minds, the story would read quite differently.*

Basis of Culture.—Mode of living by no means prove fundamental differences in ability. There are many instances, especially in the Southwest, where tribes or parts of tribes have changed their mode of gaining a livelihood. Both the Mancos and the Navajos are examples of nomadic tribes becoming sedentary people or villagers. On the other hand the Papagos⁷ of Arizona, the Pima, and the Kwahadt⁸ are tribes who abandoned their village life and became nomads. Many more instances could be cited where wholesale migrations occurred when the difference in natural surroundings became sufficient to bring about a more radical change in the habits of life. What is more, no tribe may be regarded as wholly nomadic, for even the tribes like those of the Great Plains had more or less permanent camping places in the different seasons of the year as they followed the seasonal migration of the buffalo. Much evidence exists that the Cliff-dweller did not occupy his stone palace during the entire year,⁹ although he was no doubt one of the most sedentary of all the tribes.

* An interesting booklet is "Our Debt to the Red Man," by Louise Seymour Houghton, The Stratford Co., Boston (1918).

⁷ Bandelier; Archeological Institute of America, IV, 583.

⁸ Fewkes, J. Walter, Bureau of Am. Ethnology, 28th Annual Report (1906-1907), 153.

⁹ Fewkes, J. Walter, Bureau of Am. Ethnology, Smithsonian Institution Report (1919), 421-426. Two Types of Southwestern Cliff-houses.

Neither does the ability or will to build set one group against the other as to their advancement. This is more a matter of environment than ability or tribal difference. The southern Pimas, at the time of the Spanish explorations, were living in solid houses made of adobe. Each village had a central place of refuge and had been definitely planned for defence. On the other hand, the north Pimas and the Papagos, near relatives of the southern Pimas, occupied only huts, and their villages could in no wise be compared with those of their southern kinsmen. Similarly, the Navajos became agriculturists with irrigated fields and lived in log cabins; while the Apaches, near kinsmen, built no houses, and moved hither and thither wherever subsistence might be gained either by the chase or by murder or rapine.

Advancement is not to be measured by any one particular thing. We are wont to measure others by making ourselves the standard. We cannot measure the progress of the Indian by our standards, using our measuring stick on the Indian who has climbed a totally different cultural ladder. Nor can we set off one Indian group against another that has evolved its culture in an entirely different environment. Each region, distinctive in its natural conditions, produced its characteristic culture. This was particularly so because of the difficulties and handicaps to travel. It is difficult to realize that the Indian was limited in his movements to the distance his own feet would carry him and no farther. Furthermore, all his supplies and the fruits of his forays had to be transported on his own back. Consequently, his travels and largely the distribution of his culture were limited to the region where he was familiar with the natural conditions. This does not mean, however, that the Indians frequently did not travel great distances. We know the New York Indians in historic times reached Illinois and Kentucky, but there is no record of their crossing the Great Plains, an entirely different province. Articles of commerce traveled across the entire continent, but this does not mean, necessarily, that the Pacific Coast Indian ever saw the Atlantic Ocean. The people of each natural region had learned to live there under the prevailing conditions and became more or less helpless when out of their accustomed environment. The traits developed in the one region cannot with propriety be set off against the traits developed in an entirely different region.

The Importance of Food.—Since the fundamental factor in the life of the Indian was the getting of food, his habits of life, even his mode of thinking, was controlled largely by the natural conditions which

determined the type of food.¹⁰ Each region had to be sufficient in itself except for the little trading done near the border. Each region, then, was much more of a complete geographic unit than any region could be in this day of transportation facilities.

The Indian of any natural province where conditions and food supplies were very much the same had learned, undoubtedly, how to feed off the region through which his raids carried him. In a region like his own he could go on a raiding trip for weeks without carrying supplies, for he knew what to expect wherever he went. If Stefansson has demonstrated, as he claims, that he can make Polar Regions, over which he passes, supply him with food, he has demonstrated nothing new as far as the Indian is concerned. He could not do this at first, but with an acquaintance of conditions he learned to get all the food he needed. As we would not expect a city dweller unacquainted with polar conditions to succeed amid fields of ice and snow, even if the thing can be done; so we may feel sure that the Indian, when out of his own familiar environment, was just as helpless. Therefore, the Plains Indian was separated from the eastern woodlands Indian by a barrier greater than the Mississippi, and the plainsman from the plateau farmer by a greater barrier than the Rocky Mountains. Had conditions been uniform throughout the land, there would have been no distinctive cultures in different parts of the country.

In the Southwest, of which the Mesa Verde is a part, a culture sprang up which was quite different from that of other regions, such as of the Plains, or of the eastern woodland region. In this region the people depended more on their own crops than anywhere else. With little native vegetation and that which does exist protected by thorns or bitter taste, there is little or no game and, consequently, little or no food for the nomadic Indian. Life, if it exists at all, must depend on other things than native food supplies. The Indian, in the beginning when he entered this region for the first time, unquestionably was forced soon to migrate to other regions more favorable, or to make the region more favorable to life by making it produce the necessities of life. The Pueblo chose the latter. After he had once established himself, he was fairly well protected from the raids of the nomads, because, lacking transportation facilities other than his own back, it became a hazardous undertaking for the raider to travel several hundred miles, or even a score of miles, not knowing what the outcome of the raid might be. Under these conditions so

¹⁰ See Wenzel, Clark, *The American Indian* (1917), Ch. I, The Food Areas of the New World.

markedly in contrast with the abundance of plants and animals elsewhere, it need not be surprising that the adaptation of the Pueblo Indians to the natural conditions should bring about markedly distinct traits summarized as follows:

"The culture of the whole may be characterized first by certain traits not yet found in our survey of the continent; viz., the main dependence upon maize and other cultivated foods (men did the cultivating and weaving of cloth instead of women, as above); the use of a grinding stone, or metate, instead of a mortar; the art of masonry; loom or upward weaving; cultivated cotton as textile material; pottery decorated in color; a unique type of building; and the domestication of the turkey. These certainly serve sharply to differentiate their culture.

"While the main dependence was placed on vegetable food, there was some hunting; the eastern villages hunted buffalo and deer, especially Taos. The most unique hunting weapon is the flat, curved rabbit stick, in fact, a kind of boomerang. Drives of rabbits and antelope were practised. The principal wild vegetable food was the pinon nut. Of manufactured foods, piki bread is the most unique. In former times, the villages often traded for meat with the more nomadic tribes. Taos, Pecos, and a few of the frontier villages used buffalo robes and often dressed in deerskins, but woven robes were usual. Men wore aprons and a robe when, needed. In addition to cloth robes, some were woven of rabbit skin and some netted with turkey feathers. Women wore a woven garment reaching from the shoulder to the knees, fastened over the right shoulder only. For the feet, hard-soled moccasins, those for women having long strips of deerskin wound around the leg. Pottery was highly developed and served other uses than the practical. Basketry was known, but not so highly developed as among the non-Pueblo tribes. The dog was kept, but not used in transportation, and there were no boats. The mechanical arts were not highly developed; their stone work and work in wood, while of an advanced type, does not excel that of some other areas; some work in turquoise, but nothing in metal. Art flourished chiefly as pottery decoration and in ceremonial painting; the latter tended to be symbolic but usually bordered upon the realistic; a complex social grouping in which relationship is usually maternal, but the unity of the system is apparent in that the same group names can be traced throughout the different villages; each village independent with an elective governor and a war chief, the final sanction, however, resting with a supreme religious officer; ritualism very complicated; universal offerings of maize meal and other objects at shrines; extensive use of sand painted altars; purification by emetics and headwashing; two sets of priests and ceremonies, one for summer, the other for winter; many societies or cults; a snake dance among the Hopi and a rain ceremony at Sia are special demonstrations; the most common are the kachina ceremonies, part of which are masked dances; mythology characterized by migration tales." Wissler, *op. cit.* pp. 224, 225.

From a comparison of different cultural groups in North America it becomes strikingly evident that, although the culture of each area is on the whole distinctive, yet the contrast is not significant. The one group excelled in one thing, the other in another, but each excelled in those things which were based upon and which were the outgrowths of the environment which in turn supplied their fundamental wants.

Each had its own separate culture largely to the extent to which the environment made specialization in the supplying of fundamental needs necessary.

THE PUEBLO CULTURE.—The Pueblo culture of the Southwest, to which the Cliff-dweller belongs, was only a part of a larger group of an advanced type. In Columbian days, we know, there were three important plateau culture centers in the New World. The Inca area with its center at Cuzco, Peru, in many respects the most advanced of them all; the Aztec area of Mexico; and our own Pueblo area of our Southwest, covering New Mexico and Arizona and extending into Utah, Colorado, Texas, and old Mexico. Practically all of this cultural area, extending from Colorado into northern Chile, is of the high arid plateau type. There are, however, many barriers, the major of which separate the area into these three divisions. Intercommunication between them is very difficult; consequently, each section developed its own special characteristics. In general, however, their governments, much the same in each, were highly organized on a highly communistic basis, leaving little or nothing to the individual initiative. The system was based on the family group. They were all agriculturists, not only growing crops, but supplying them with water and fertilizers. Fertilization of crops, however, was nothing new, for it was practised as far away as Nova Scotia where the fertilization was done with dead fish. The Incas had domesticated the llama and alpaca, and our own Peublo the turkey. Although the Incas had the dog, they did not use him in transportation, as did the Indian of the plains. The dog, like the monkey and guinea pig, also domesticated by the Incas, was no more than a pet to them. The Incas and the Aztecs also were familiar with the smelting of metals and the making of true bronze, using tin. A very high technique in metal working had developed, especially in gold, although the metals rarely entered into the making of tools. The plateau group did some excellent work in copper¹¹ and in the preparing of turquoise. Above all, however, it is interesting to note that these people had learned to domesticate animals, and to use metals and alloys. There can be no question as to their inventive ability when the lists of all their accomplishments are reviewed.

Although the Cliff-dwellers present the most striking evidence of progress and skill of this culture in the plateau region, yet their culture is not of the same rank as that of the Incas, or Aztecs. At the

¹¹ For an excellent survey see "The Primitive Copper Industry of America" by George Brinton Phillips, *American Anthropologist*, XXVII (1925), 284-290.

time of the Spanish exploration into this area, there were in general two different types of Indians of the region. The one was the sedentary, home building type, Pueblo or villager; the other was the nomadic or semi-nomadic type, such as the Ute, Apache, or Navajo. The modern Pueblo Indian we are assured is the descendant of the Cliff-dweller.¹² Various lines of evidence lead us to this conclusion, such as antiquities, tradition, and somatic characteristics. There are evidences also that there have been certain retrogressions in culture from the early Pueblo or Cliff-dweller to the present Pueblo and that some of the most desirable qualities have been lost. Just as the Maya culture of Yucatan was displaced by the somewhat lower type of Nahua culture of Mexico. It must not be lost sight of that our knowledge of the anthropology of the Southwest has come most largely from the inhabited Pueblos of the present day, and it is from them that we get our key with which to unlock some of the mysteries of the past.

To make living conditions more favorable, or even possible, in the arid Southwest the Indian was fortunate in the possession of one of mankind's most valuable plants, that of maize.¹³ Its origin and its first domestication is still unknown, but its history has been a part of the earliest history of American Indian development, and the cereal most properly is called Indian corn. Ears or grains of maize have

¹² My conclusion is that the rise, culmination, and decline of two different phases of architecture occurred in two regions of the Southwest, each developing independently or along its own lines of growth. In the course of their history the inhabitants of these two areas increased in number and the horizon of each culture area coming in contact overlapped, forming a zone with characters of each. Here their descendants survived among the Hopi and Zuni up to our own time as a mixed people, still further modified by foreign influences retaining certain elements of each area. Survivals in the modern pueblos have brought to our time the *membra disiecta* of past phases of culture, and still have a great deal to teach us regarding the past.

—Fewkes, *op. cit.* p. 426.

¹³ I have spoken above of maize, the supposed gift of the Gods, which he brought to the cave country. The foundation of all culture is the maintenance of a food supply, and the first steps in the advancement of the human race were the discovery of an artificial means for increase and regulation of that supply. The bulky food supply of various products of a vegetable nature requires storage and the agriculturist is driven to seek out places to contain it or to construct bins for that purpose. Here we have one of the most important reasons why the agricultural Indians of the mountains originally adopted caves for preservation of their food supply. The improvement of this shelter by the erection of bins naturally followed; consequently, in studying the relations of cliff dwellings to man's development of our Southwest we should always have clearly in mind the storage of corn, which was so important under early conditions and the necessity for which survives to the present time.

The production of the food supply of an agricultural people is limited to a part of the year. From harvesting to planting the earth yields nothing. Man then consumes an accumulated supply of food. Then it was that the cliff-house farmers retired to their caves, in which they had stored their corn, seeking whatever comfort was possible. Thus the cliff-house became the winter residence of the farmer. Fewkes, *op. cit.*, p. 422.

been found in the oldest ruins of the American Indian, whether they be the tombs of the Incas, the catacombs of Peru, or the cliff-dwellings of the Southwest; even religious customs were woven around it in both continents.

THE IMPORTANCE OF CORN.¹⁴—Judging from the specimens found, some of the maize of the early day was much inferior to that grown at the present time, as is shown by the short thin cob about the size of one's small finger. The yield must have been extremely small relative to present yields; yet no other cereal could have vied with it under the existing conditions of the time. The Old World had no plant which needed similar activities for its cultivation. In the Old World there was barley, wheat or spelt and rye, demanding an entirely different type of cultivation. Corn is essentially a hoe crop which needs constant care and attention. The other cereals are predominantly field crops. Each type calls for different activities. In the Old World under the same primitive conditions the sowing and harvesting of the crop were the great problems. After the seed was in the ground, it needed no more attention until harvest time. With corn the chief work was not ended with the sowing, but had scarcely begun with the simple process of dropping a few kernels into a hole. There was the constant care and attention necessary to keep down the other vegetation, for it cannot be sown thick enough to form its own protection, as can the other cereals. Here may be a fundamental difference in the beginnings of culture in the Old World and the New.

It would be difficult to find a plant more suitable for Indian cultivation than corn. It is easily planted, a rapid grower, with strong stem soon out of reach of the depredations of small animals. Little attention or entire neglect may ensure, nevertheless, a very fair crop; while much attention with thorough cultivation is sure to bring its reward. The roots penetrate deeply, and in this way it resembles desert plants and thus is able to withstand severe and protracted droughts and yet yield a fairly good return. Although few crops are so sensitive to proper moisture conditions, yet corn will fruit some under the most adverse conditions. Under primitive conditions it lends itself excellently to irrigation. The seed is easily carried long distances to a favored spot, and the entire crop is easily handled while in the ear and no threshing is required. Besides all this, it is an excellent food, containing much more oil than any of the other cereals and, therefore, added another important food element to the

¹⁴ For the early "History and Geographical Distribution" see Ch. III of "The Story of the Maize Plant" (1923), by Paul Weatherwax.

limited diet of those forced by conditions to depend almost wholly on a vegetable diet. Fats must have been scarce for the quantity was limited to that from pinyon nuts or from the animals of the region. The relative protein content is also large, making it a fairly well balanced ration.

The consequent effect of the growing of corn in this region was very marked upon the scant populations there. In a semi-arid region where there is little vegetation, at least of the succulent type, great care must be taken of the growing crop to keep it from the ravages of the small animal life; such as the gopher and the jack rabbit. This necessitates staying close to the crops. In such regions, therefore, the crop becomes the all important thing, for, if this fails, it means migration or starvation. In the Mesa Verde region the crops must be put in at the proper date. Even at the present time the ranchers with permanent water rights try to get their crops in as early as possible in order to get the advantages of the early spring rains and a low sun. If the oats is sown early enough to be up before the spring rains cease, no irrigation is necessary. If the spring is unfavorable, however, and irrigation is necessary to sprout the grain, the land must be irrigated at the proper intervals until the crop is mature to insure a fair yield. Such conditions hardly can be thought of as favorable to roving dispositions.

The Cliff-dweller, therefore, who was wholly or almost wholly dependent on crops for his food had not only to stay close to the crop, but he had to be present at the proper time to do the things essential to secure his crop. During historic times, the Apache, on the other hand, in the same general region as the Moqui, has lived in the mountainous areas with small but fertile valleys and in a country which yielded considerable game, roots, nuts, and fruits. He did not need to stay at home because he was not dependent on his home crop; but he could roam about and find enough to eat, when the pinch came, by foraging on the native products of the country through which he roamed. Thus the Apache has been a wanderer, while the Moqui has lived a sedentary life in communities.

ABILITY AND CULTURAL ADVANCEMENT.—Measured by our standards, the culture of the Cliff and Pueblo Indian is considerably higher than that of the roving tribes. This, of course, does not imply a higher mentality or a greater degree of skill, for the abodes of nomads sometimes indicate greater skill on the part of the builders than that of the village Indian. Thus, even the Comanche tent is by no means a contemptible achievement. It is also unfair to extol the stone house

at the expense of the wood. The loghouse of the Iroquois was a very intricate structure, and the same may be said of the homes of the Alaska tribes. It may be well to bear in mind that it is much more difficult to frame than to pile, and that most of the stone or adobe work of North America is only careful piling. The nomad may be more intelligent even than the village Indian. There is the difference between the man who has travelled and the man who has lived in a little village all his life. The example of the Navajo shows that, when a nomad once gives up his objections to permanence of abode, he may become more successful and enterprising than the villager.

The ingenuity of the roving Indian was brought into play very probably much more frequently than that of the sedentary Indian. The difference between the two is a matter of concentration; the one made his living by hunting, and concentrating his energies on the chase; the other made his living by the growing of crops in a somewhat secluded desert region and concentrated his energies on the growing and storing of foods. The native Indian did not do this from choice, but rather from bare necessity, for he followed the lines of least resistance. That some tribes were much keener and more alert than others is a matter of common knowledge, but to attribute a keenness or a brilliancy to the Cliff-dweller beyond his brother Indian, merely because he had advanced farther along certain lines, is unsound. Some of the Pueblo tribes may have been the more brilliant and enterprising and definitely set out in search of a desert to conquer, but the chances are greater that originally he was driven out by his keener or more powerful neighbors and was forced to take up his abode in this more inhospitable country which may or may not have proved a blessing to him.

THE BEGINNINGS OF THIS CULTURE.—As to what was the original culture from which all these variants came which we now recognize is still a mooted question. That the American Indian is closely associated with certain hill tribes in eastern Asia is fairly well established; but were these early immigrants all from one stem or were they even from one migration across the North Pacific is unknown also. They may have been from one stem and one migration, or they may have been from one stem but of several migrations or for a time a series of migrations with different degrees of advancement; or even there may have been many migrations, some of which, widely separated in times, formed groups of widely different cultures.

The most vital problem in a study of Indian culture is what did the Indian bring with him? If he is a product of the Old World,

man separated from the rest of his fellow beings by geological changes and become somewhat fossilized, like Australia's life with its geological separation from Asia, then we have to examine the facts in this light. If he is an American immigrant, on the other hand, of relatively late times, there are many possibilities as to the type and degree of development he had attained at the time of his migration. Unfortunately, we know so little of early Asiatic culture that the answer to the question seems to be insolubly bound up with anthropological investigations there. With a knowledge of the early cultures there we may hope to have answered some of these questions seemingly unsolvable today. But then there may be found also good reasons for believing that eastern Asia was peopled in part from the American continent and that there may have been many migrations back and forth extending over a long period of time.

A host of other problems arise and the whole question becomes most complex relative to this differentiation of culture. Even if the ancestors of the Indians crossed over from Asia early, in one group from one stem, how and when did the dispersion occur? Was there more than one dispersion center? Did the dissemination throughout the continent come suddenly in another Tower of Babel way, or were there many departures from the original center or centers separated by long intervals of time? After one culture had been established, did another come and displace it, similarly to the Hun invasion, and did this culture in time pass through the same development that their predecessors did? If similar traits are found in widely divergent groups, does that mean a sameness of origin, a sameness of conditions, or a sameness of something else? Or did these similar traits come into existence separately and absolutely independently?¹⁵ Our knowledge of the American Indian leaves all of these questions still unanswered. We do know, on the other hand, that evolution is an extremely slow process. Social, as well as physical, evolution is possible largely only through mutations. Social habits when once thoroughly established are most resistant to change and survive long after the conditions which brought them into being have passed away.

If we accept, however, that "the New World received a detachment of early Mongoloid peoples at a time when the main body had barely developed stone polishing,"¹⁶ then the development found among the American Indians was largely, if not wholly, a result of the environ-

¹⁵ On the distribution of traits see: Clark Wissler, "The Relation of Nature to Man in Aboriginal America," 1926.

¹⁶ Wissler, "The American Indian," p. 363.

ment here. If this is true, how old this culture is in relation to that of the white race cannot be stated positively, for the stone polishing age for Asiatics was not necessarily the same as that of west Europeans. However, the progress made by the American Indian in the various arts seems extraordinarily slow in comparison to that of other continents. Perhaps this is only seemingly so, for probably by the tenth century Mexico was in a more advanced stage of civilization than Denmark, Sweden, or Russia.¹⁷

Whatever the solutions to a host of problems still unsolved, we may safely start on the assumption that here was a race of naturalistic men, evolved culturally according to the conditions in which they were placed. Had the scene of activity been on another planet, he could not have been culturally more isolated¹⁸ than he was. What he was he had evolved for himself; he had borrowed nothing. The Americas, from this point of view, were huge laboratories where according to conditions of each natural region a corresponding type of culture was evolved. Why he had not advanced farther when conditions from our point of view are so favorable is not an easy question to answer decisively with our present degree of knowledge. It suggests, however, a fertile field to the student of geography.

THE REAL PROBLEM.—Relatively much has been done in studying and describing the various ruins and other antiquities of the Mesa Verde region, but no systematic effort has been made up to this time to study the natural environment from which sprang this early culture. The work done has been in the describing of the major and minor antiquities, rarely in an interpretation of these in relation to the environment, an environment which we now consider highly unfavorable for modern development. As a result of this unfavorableness of conditions, the Plateau Province is at present the least densely populated and the least developed large area in the United States. In the time of the Cliff-dweller, however, the conditions were just the reverse; at that time this was the most densely populated large area north of the Rio Grande. With this greater density of population rose also the greater degree of culture. It seems anomalous to us now that in an area as large as the United States and Canada, with so great a variety of conditions prevailing, that the highest type of culture should arise in one of the roughest sections of the country, where the rainfall is extremely sparse and erratic. Manifestly the most favorable

¹⁷ Humboldt, "Researches in America," p. 83.

¹⁸ This isolation is emphasized by W. E. Safford in the *Scientific Monthly*, XXII (1926) 55-60, "The Isolation of Ancient America as Indicated by its Agriculture and Languages."

conditions for primitive man cannot be the most favorable for modern activities.

PRESENT ISOLATION OF REGION AND PARTS.—Situated climatically as it is, the Mesa marks also the limits of the sedentary white population in southwestern Colorado and in general also the limits of a country productive of forests, live stock, and crops. To the south and west of the Mesa Verde are the Ute and Navajo Indian reservations, respectively, with small numbers of various kinds of live stock that manage, on a relatively large desert range, to thrive surprisingly well. With this resource and a little irrigated agriculture, together with some government help, the Indians, as a whole, are no doubt fully as prosperous as their ancestors were in pre-Columbian time. Only one railroad, the Denver and Rio Grande Southern, serves this part of the state and provides an outlet for the products of the white man of the region. The service on this line, however, is very poor and at times suspended altogether on account of snow, landslides, wash-outs, or other accidents.

The mesa with its many Indian ruins may be reached easily from Mancos by automobile over an excellent government road in a few hours.¹⁹ The road in rising from the low Mancos and Montezuma valleys follows more or less along the northern rim of the mesa for about twelve miles and offers wonderful views both to the south over the mesa and to the north over the Montezuma Valley and the Dolores Plateau. Other points in the park not on the main road are reached, however, only with difficulty. There are no roads, and some sections, too rough for cattle, are even without trails of any kind. In the grazing area there are cow paths worn down by the cattle in search of water or better pasture. These trails are winding, leading into all sorts of blind alleys, and, when passing through regions of trees or brush, are uncomfortably low, making it impossible to use a horse with saddle. Upon some of the steep slopes the brush is so dense as to necessitate cutting or breaking one's way through slowly foot by foot, or after some skill has been developed in the art of walking upon the tops of bending bushes down the slopes. In addition to the dense thorny brush of some sections, the region is so broken up by deep canyons that it becomes necessary in places to make a detour of many miles to get on the other side of a canyon which may be less than an eighth of a mile wide at the rim.

¹⁹ The Park may be entered also by auto stage from the south with Gallup, New Mexico as the gateway. The round trip from Gallup may be made in three days, allowing one day in the Park. This route has the advantage in being connected with a main line railroad, the Santa Fe.

During the best days of the Indian conditions probably were markedly different. Many of the flat areas now covered with oak scrub and other brush undoubtedly were used as agricultural lands if the distribution of quantities of pottery is an index. The roughness of the country, however, was the same. Movement north and south on the plateau between canyons is relatively easy, but travel east and west across canyons is most laborious and in the southern section impossible except by following a few old Indian trails. As shown on the topographic map²⁰ these trails are still in evidence and afford at the present time the only routes for cross canyon long distance travel. The general roughness and scarcity of water must have made it for the Indian, as it is for the white man today, a most difficult country for long distance travel. It would seem that any Indian groups of the region would always have been fairly free of raiding parties from the outside.

THE MESA A PART OF THE PLATEAU PROVINCE.—The Mesa Verde is only a small part of the high tablelands of the Southwest, designated by modern students²¹ the Colorado Plateau. As a part of the much larger physiographic province it and its early inhabitants can be studied only in relation to the larger area. The leading characteristics of the Plateau Province are the nearly horizontal strata, elevated in the higher part to some 10,000 feet or more. The region, however, is extremely rugged, due to deep canyons, fault scarps, and cliff development. The great number and depth of the canyons, the perpendicular and even overhanging cliffs, together with the aridity of the region, makes the Colorado Plateau not only the roughest, but also the most difficult of travel and the least known of all physiographic provinces in the United States. In the degree of canyon dissection the area has no parallel anywhere in the world, and parts have been aptly designated by Powell as the "Canyon Lands."²² Although the Mesa Verde is only a minor part in area (about 80 sq. mi.), yet as an erosional unit in number and depth of canyons it has few if any equals.

The Mesa Verde, therefore, is one of the striking physiographic features of the Southwest. It is also one of the highest mesas of the plateau regions and offers some exceptional views. From Park Point in the north the nearly horizontal strata stretch out to the south-

²⁰ Special Map, Mesa Verde National Park (1915). A revision of the map is now underway.

²¹ Bowman, Isaiah, Forest Physiography, p. 256.

²² Powell, U. S. Geol. and Geogr. Survey of the Rocky Mt. Region (1879), p. 105.

west over the plateau in a vast flat expanse where the vision is limited only by the blue haze of the horizon. The seeming general flatness is broken by a few island-like igneous projections, extending here and there above the vast sea-like expanse. The LaSalle and Blue mountains of Utah, with the Ute Mountains in the foreground, may be seen far to the west; the Carriso Mountains lie to the southwest in Arizona, as also are the Tunicha Mountains in Arizona and New Mexico. To the south in New Mexico, like a phantom sailing vessel, stands out the igneous mass, "Shiprock," some forty-five miles distant ever a landmark to one who once has seen it. At the border of the plateau province, only a few miles to the northeast, are the LaPlatas, a part of the San Juan group; while to the south of these extends Red Mesa. To the north, in the far distance rise the snow covered peaks of the Rico Mountains and Lone Cone; while at the foot of Park Point is the steep escarpment of the mesa with a drop of 1000 to 1500 feet to the relatively depressed southern end of the Dolores Plateau, which, because of the rise of the plateau to the north and the mesa escarpment to the south, is known as the Montezuma Valley. Such an outlook should be admirably adapted to the evolution of a religious people. Moreover, a lookout might be able to detect an enemy's approach hours, if not days, before his arrival.

THE PHYSICAL FEATURES OF THE MESA.—The mesa is set off from the rest of the region by a steep escarpment. (Fig. 3.) In general the surface is flat and gently inclined to the south. The topography of the northern part differs very materially from that of the southern, and the line that separates the two is fairly well marked and known by the cattlemen as "the break." In the northern section the canyons are shallower and divide and redivide with many side branches and spurs. The intercanyon areas become narrow and rounded, soft slopes prevailing, few of them being so steep that cattle will not graze on them. Were they in another part of the world, they would scarcely be called canyons. For the most part, it is a highly rolling topography, well advanced in the cycle of erosion and may be described as fairly typically mature.

In the southern part of the mesa the topography is quite different. The canyons are narrower, the sides being almost vertical and, in many places, overhanging. The mesa surface is fairly flat to the very brink of the canyon, whose presence is unsuspected by the traveler until an abyss opens up before him. This is true most unconditionally in the south central part in the section of the cliff ruins. Here the

greater massiveness of the stone and the somewhat decreased rainfall have preserved the greater flatness of the surface.



Fig. 3. The Mesa Escarpment with the Montezuma Valley in the Foreground. A few Indian tepees in the middle distance.

Erosion has been unusually active in both sections of the mesa. In the south more than half the surficial area lies within the deep steep-walled canyons. Taking the park as a whole, so much has been eroded into canyons that there is but little more left than a skeleton of its former self. So much is this the case that Holmes, in reference to this canyon erosion of the mesa, says:

"From without we get an idea of an unbroken well-sustained table-land, while from within we discover only a skeleton—a sort of rude wheel which might be defined as having a pretty well developed tire and spokes but no hub."²³

The highest place of the mesa is near the northern edge of the escarpment about three miles southwest of Point Lookout, at a place known as Park View Point (8,574 ft.). Altitudes vary between this and 6,700 and 6,800 feet in the vicinity of the major ruins. The difference in altitude is not due altogether to the gentle southward slope of the mesa, but to elevations above the general mesa surface. The normal surface at Park View Point is about 8,200 feet. The

²³ Hayden, Ninth Annual Report, U. S. Geol. and Geogr. Surv. of Terr. (1875), 257.

erosional remnants or monadnocks, therefore, rise up to some 400 feet above the peneplain surface.

The main canyon, and the only one with a permanent stream, is the Mancos, which enters the escarpment in the northeast, cuts south and west through the plateau, completely separating the mesa from the rest of the highland section. The Mancos River enters the canyon from a wide open valley to the north and again comes out in a broad open valley at the southwest before it enters the San Juan River. The other important canyons, all tributary to the Mancos, are the Navajo, famous for its numerous and large ruins, Rock, Horse, Soda, Morfield, and Ute. All of these canyons become shallower to the north until they either die out or their shallow upper ends are cut off at the northern end by cliff recession. The width of the canyons varies from about 500 feet to 1000 feet, depending on the character of the rock and the depth of the canyon. As a rule, the more massive the sandstone, the narrower the canyon at the top. The greatest depth of the main canyons is about 1000 feet, and the bottoms of the deeper canyons are extremely narrow, so narrow that, eliminating the steep talus heaps, the stream bed usually affords the only passageway. In fact, many of the canyons in places are blocked completely to the movement of live stock by huge talus blocks extending from one canyon wall to the other, under which the occasional freshet finds its way. The lower walls of all the canyons are steep, even vertical, and sometimes overhanging with innumerable recesses, many of whose fronts were walled up by the ancient inhabitants of the region.

In any desert region erosion is of major and drainage of minor importance, and this region is no exception to the rule. What drainage there is, however, is entirely to the south, even within a few feet of the northern edge of the mesa. Throughout the entire mesa, rains, although extraordinarily heavy while they last, produce little or no running water. The surface is sandy, usually very hot and dry in time of rain, and readily takes up what in humid regions would be considered as a heavy rain. Occasional small rivulets are formed, but usually erosion of this sort is insignificant. But water erosion is important in the form of sheet wash during the exceptionally heavy showers that sometimes fall. Almost simultaneously, however, with the passing of such a shower, the sheet wash stops and all water disappears from the mesa surface. The silt-laden water that does drop over the brink of the canyon and gets into the bottom is soon lost in the debris. The water, if it comes unusually rapidly, may produce a small torrent for short distances, but in the main it disappears as

quickly as it came. Farther down it may come to the surface again as a trickling temporary stream, only to disappear again farther on, or it may form merely seepage places, springs, or "water holes." The free movement of water and the occasional washing away of all filth unquestionably played a great part in keeping conditions more sanitary and the primitive people healthier.

Climate.—The comparative uniformity of the weather conditions from day to day is the most distinctive feature in the climate of the region. Changes naturally occur, but new weather conditions come on so gradually that one is scarcely ever aware of a change except upon reflection. In general, cyclonic storms pass to the north or to the south of the state so that the sudden changes attending the passage of a "low" and of a "high" rarely are experienced. During summer uniform conditions prevail, therefore, and the days, as a rule, are clear and hot; clouds and occasional showers are rare, except in the afternoons for a series of days, and are due, in the main, to local disturbances. There is a tendency in winter for a stationary area of high pressure to form over this part of the state and to remain here for several weeks at a time. At such times the sky is beautifully clear, and the atmosphere bracing with day temperatures well above the freezing point, and night temperatures near the zero mark. But, when changes come, one kind of weather gradually merges into another and the one season into the next.²⁴

Although the general weather conditions are remarkably uniform, the contrasts in temperature between night and day, and between sunlit and shady areas, are very marked. On account of the dry and rarified condition of the atmosphere, the summer days may be excessively hot, but the nights are invariably cool or even cold. This contrast between night and day is due not only to the general arid conditions which prevail throughout the region, but also to the general topography, admirably suited for cold air drainage from the La Plata Mountains down through the Mancos and Montezuma valleys. During the hottest part of the day the temperatures in July and August range on the average from 80° to 95° in the shade with much higher temperatures in direct sunlight. The mean for the months in question,

²⁴ Summary of the Climatological Data for the United States by sections up to 1922, section 9, Western Colorado, p. 2.

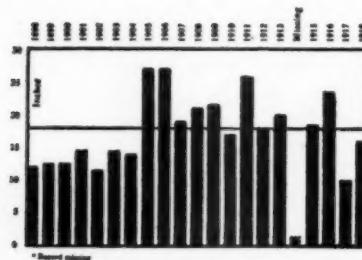


Fig. 5. Annual precipitation at Mancos (1898-1918) compared with the mean. The wide variation in amount from year to year shows the erratic character of the rainfall.

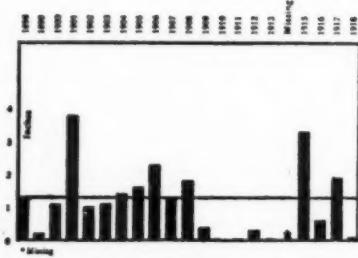


Fig. 6. Rainfall at Mancos for May (1898-1918). May is the critical month. With a good rainfall for the month vegetation will be fairly luxuriant, but with a low rainfall the growth will be small. During this month rains are more effective because the sun is still low and the ground fairly cool.

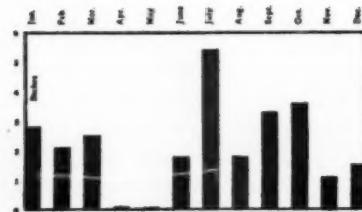


Fig. 7. The mean monthly precipitation at Mancos for 1911. Although the precipitation for 1911 was considerably above the normal (25.18 inches), yet the rain which fell was of little value to non-irrigated crops because it fell on hot, dry fields with a high sun. The critical months, April and May, were almost entirely without rain.



Fig. 8. The mean monthly precipitation at Mancos for 1917. Although the precipitation for 1917 (10.23 inches) was the smallest on record, yet the ranchers fared much better because of the more favorable distribution of the rainfall.



Fig. 9. The mean monthly distribution of rainfall at Mancos (1898-1918). Unfortunately, the station record was discontinued before the new one upon the Mesa was inaugurated; consequently, no comparative figures are available.

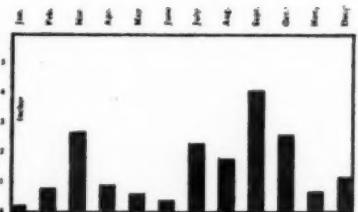


Fig. 10. The monthly precipitation at the new Mesa Verde station for 1925. The total precipitation for the year is 19.23 inches, and slightly above the mean for Mancos, which is 17.85 inches.

however, varies near the 65° mark.²⁵ The winters are fairly cold, especially the winter nights. Zero weather is not uncommon, and occasionally the thermometer may drop to -20° or even lower. Although considerable snow falls, it rarely lies on the ground long enough to interfere seriously with the winter stock range, provided enough dead feed remains from the summer's growth. The warm sun and the dry atmosphere rapidly remove all traces of snow in the open in a few days.

The Rainfall of the Region.—The rainfall mean is considerably below 20 inches. (Fig. 5.) At Mancos the mean is 17.85 inches. Although the general weather conditions are about the same from day to day, the rainfall is remarkable for its extreme variability in amount and distribution. (Figs. 6, 7, 8, 9, and 10.) Being independent of cyclonic storms, and dependent mainly on local disturbances, it is fitful and unreliable. The general rise of the Colorado Plateaus toward the interior of the continent is so gradual that the atmosphere is heated much more rapidly by the sun than cooled by adiabatic expansion; consequently, there is little or no rainfall. However, when the southwesterly winds approach the San Juan group, they are forced to rise rapidly, with a consequent cooling and precipitation, when conditions are at all favorable. The foothills of the La Platas, therefore, have sufficient rain for a dense growth of vegetation. Mancos, about eight miles to the southwest, has less rain, and the Mesa Verde, about twelve miles still farther, has much less than the region immediately in the vicinity of Mancos, although the elevation of the northern part of the mesa is considerably greater than that of Mancos. The Mesa Verde receives more rain than the other plateaus to the southwest, partly because of its greater altitude, but more especially because it is nearer to an extensive area of much greater elevation.

The very low relative humidity has an important bearing on the rainfall, for much of the precipitation evaporates before it reaches the ground. In this region the La Platas are the first to receive rain because of their greater elevation and because they are in regions of greater relative humidity. Many showers occur over the plateau

²⁵ The climatic data referred to in this chapter, unless otherwise stated, are for Mancos, the most southwesterly weather station in Colorado. The data here used, however, are of comparative value only, for the region as a whole, and are the best that are available. Mancos, although by air route only about six or seven miles from the edge of the mesa, is situated in the Mancos Valley and at the foothills of the La Plata Mountains. The climatic record, therefore, is a hybrid between that of a mountain and desert type of climate, affected in the winter more by the mountain conditions, and in summer by the plateaus. The mesa, therefore, has more of a desert climate, hotter and drier, especially in summer. The station has been moved to the mesa and records of 1924 and later are available from there.

section when the humidity and cooling of the upper air is great enough to cause condensation, but no rain reaches the earth because it is evaporated again while falling through the dry hot layers of air below. These phenomena, common to the region, are known as "streamers" because they give the effect of banners with fringed lower edges moving across the sky. It is not uncommon to count a dozen or more of these streamers along the horizon on some afternoons. With their increase in number, there is also, as a rule, a decrease in the distance between them and the earth, showing a gradual lowering in altitude of the zone of high relation humidity. As the humidification of the air increases, the banners reach lower and lower, finally touching the earth first at the base of the mountains, and then gradually extending their areas of contact with the earth to lower altitudes and to greater distances from the mountains. A change in local atmospheric conditions halts this migration, and it is only in unusual seasons of rainfall that the rainy belt succeeds in migrating as far as Cortez in the Montezuma Valley. Several weeks may pass before the same routine of humid weather conditions again returns.

These conditions are important in explaining the distribution of rain in this region. During this series of a week or more, places nearest the La Platas are the first to get rain and usually also the last. The areas farther from the mountains, like Cortez, may be on the edge of the humid belt and receive only one shower, while Mancos may have had a week of rainy weather; or Mancos may have several days of rainy weather, while Cortez may not even have a dense gathering of clouds. As a result, a few miles more or less from the base of the mountains may make considerable differences in the amount of rainfall. Four or five miles east of Mancos in the foothills of the La Platas the rainfall is sufficient each year and so well distributed as to support a luxuriant vegetation; while at Cortez, about sixteen miles west, only the most drouth-resisting plants survive without irrigation. In 1912, the volunteer observer²² at Cortez reported no precipitation for the year except a trace in May; Mancos, on the other hand, with a precipitation record of 17.89 inches, was up to the normal. The fact that higher places get the most rains leads to the popular local belief that "the rain follows the divides," or "it breaks on the high places."

The migration of the edge of the moist belt from the base of the La Platas over the plateau brings about great fluctuations of rainfall from year to year for the park region. Conditions are such that even at Mancos the departures from the mean are rather exceptional. The

²² Op. cit. p. 4.

fluctuation over parts of the Mesa Verde is much greater because the mesa lies directly in that shifting borderline separating the arid and semi-arid sections from the sub-humid and humid. The fluctuation is not only greater than at Mancos, but also greater than at Cortez, for the rainy belt rarely migrates that far. In 1911 the precipitation for the region southwest of Mancos was mapped as having more than twenty inches of rain, as heavy as anywhere in the state, while for the following year, 1912, the same region was mapped as having less than ten inches, as light as anywhere in the state.²⁷ In the spring of 1912 some of the ranchers southeast of Cortez were considering the advisability of changing from irrigated to dry farming, arguing that for several previous years the rainfall had been so heavy and so well distributed that not sufficient benefit was gained by irrigation to warrant the payment of a water tax at \$4.00 per acre; but the summer had not very far advanced before they realized that it was better to pay for the water and not need it than to need it and not be able to get it. During the summer of 1913 dry ranchers east of Cortez experienced almost a total failure of crops, because there had not been sufficient early rain to sprout the seeds of their spring planting. In the summer of 1914 there was so much rain that farmers scarcely needed to irrigate and in the Mancos Valley they were much handicapped in the harvesting of the crops because of the persistence of rains during that part of the season.

Seasonal Distribution of Rainfall.—The seasonal distribution of rainfall is another important factor in the precipitation of the region. There are two rainy seasons not strongly marked in some years, however, and not shown at all in others. The March-April season brings the spring rains and the July-August the late summer rains. May and June have little rain, especially June. There is, however, no definiteness in the monthly distribution, and the fluctuations for each month, from year to year, are large. What makes the value of rain still more uncertain is that summer showers may be unusually heavy and very brief. These are reported as cloudbursts and such reports are common. Almost the entire rainfall of the month, may come in one shower which lasts but a few minutes. Storm clouds may gather with extreme rapidity, promising only a light shower, but which may cause a heavy downpour, flooding the region. Dry arroyas at such times become torrents of muddy water and debris of various sorts carrying immense loads of silt. In a few minutes the sky may be clear again, the water in the arroyas disappeared, and the moisture

²⁷ Annual Summary, U. S. Weather Bureau, Colorado Section. (1911-1912), p. 11.

penetration so shallow that the dry earth may be dug up less than an inch below the surface. Such a shower, followed by a hot sun, and with an atmosphere of low humidity, has little effect on the moisture content of the soil and, consequently, very little on the vegetation.

Because of this distribution of rain the mean annual rainfall does not give a fair index to the moisture conditions controlling plant life or to the amount of erosion. The spring rains are the most important for vegetation, and, when little rain falls during March, April and May, vegetation springs up only in protected places. With no vegetation to protect the earth from the drying sun and winds, the ground soon becomes dry and hot. Summer showers are rarely ever sufficient to start germination of seeds, because rains are not followed by cloudy days and the moisture thus prevented from immediate evaporation. The late summer rains are of little value, except for grasses and alfalfa, for this is the harvest season. These rains are also of little value to the general vegetation for the ground is dusty and hot, the percentage of run off is exceptionally large, and the sun, coming out immediately after the downpour, soon dries up all traces of moisture resulting.

Some Climatic Effects.—These climatic conditions produce interesting results. Stations not very far apart may show entirely different results as to the annual or monthly precipitation. A station record may show a year of heavy rainfall, but, because of the distribution of the rain, it may have been of little value to vegetation. The station's report of having had rainfall above the normal may have been an exceptionally dry year for the rancher within a few miles of the station, or *vice versa*. The erosional work resulting from such a rainfall is also far out of proportion to what might be expected. The amount of the material moved by a single heavy shower is enormous. With a mean rainfall of about eighteen inches, distributed as noted, conditions seem to be about ideal to bring about the minimum amount of plant protection, with the maximum amount of erosion.

What this type of rainfall may have meant in the agricultural life of the early inhabitants of the region is not difficult to picture. We have abundant evidence that the scarcity of water was a serious problem to them, especially the insufficiency for plant life. As an agriculturist he had to produce his food if he wished to live. Whether conditions were as severe then as they are now we do not know,²² although there is

²² Investigators of Indian antiquities of the Southwest almost invariably come to the conclusion that there has been a gradual dessication of the region. It is difficult to explain the number, distribution, and extent of the ruins on the basis of present climatic conditions. To prove, however, that dessication has actually occurred is a difficult matter. The literature on the subject is abundant, but the most scientific discussion will be found in an article by Henderson and Robbins, *Climate and Evidence of Climate Change*. *Smithsonian Institution, Bur. of Am. Ethnol. Bull.* 54, (1913), pp. 43-77.

some evidence along several lines which point strongly to a slight progressive dessication within the last four or five centuries.

Whatever the conditions, they were severe enough to tax all of the Indian's resources. Dry farming is practiced today in the region, and the Indian also planted some crops wholly dependent on the moisture from the rain which fell. It is a far cry, however, from a well plowed and harrowed field lying fallow with an earth mulch for a time to store up moisture to an unplowed and uncultivated field where corn has been planted in shallow holes dug out by a blunt stick. If the modern dry rancher fails to make both ends meet and abandons his fenced land with all of its improvements, what kind of a crop may we expect for the primitive agriculturist under present conditions? However, crops that bring bankruptcy to the farmer may have been considered excellent by the Indian. That large areas were thus cultivated we know, but that crops were poor we can only surmise from the kind of stalk and cob found in the ruins. Perhaps planting with him was a gamble with much to win and only his seed to lose. Perhaps in years of greater rainfall he harvested a crop, and in years of lesser rainfall there was none to gather.

However, he did not always depend on the erratic rainfall. Irrigation from permanent streams was common. Parts, perhaps all, of the Mancos Valley, where today such excellent crops are grown under irrigation, was under water then also. At least the whole valley must have been very densely populated if all the ruins found in the valley by the early explorers were inhabited at one time. As all of these ruins were of adobe and small stream boulders, they have practically all disappeared, as well as irrigation evidence, before the ranchers plow and harrow. There are no evidences, however, that ditches comparable in size to those in the Salt River Valley were ever built in the Mancos Valley.

Vegetation.—The natural vegetation of a region in many cases is a better index of actual climatic conditions than is a weather station record. All plants require a certain minimum of moisture throughout the entire growing season, some require more, others less moisture. If the seasonal distribution is erratic, the vegetation will correspond to the driest periods of the growing season and not to the less dry ones. If six inches of rain is sufficient when distributed in time favorable to the existence of a certain plant, then twenty inches differently distributed may be too much or too little. Even with a rainfall of 25.98 inches, as in 1911, true desert conditions prevailed for April and May, the two most vital months of the growing season. On the other

hand, with only 10.23 inches of rain in 1917, the growing months, April and May, had well above the normal and the ranchers reported a better year than for 1911, with nearly two and a half times as much rain as for 1917.

The natural vegetation, similarly, is governed more by the distribution of the rainfall than by the total amount. In years when the rainfall is less than two-fifths of what it is in other years, taking for granted that the seasonal distribution is the same, the type of vegetation is determined by the lean years and not by the occasional year of greater rainfall. The rich years will add to the luxuriance of growth, but will not change the type of plant life. The lean years, especially when also the distribution is unfavorable, are the critical ones. As a result the region has much more of the desert type of vegetation than the mean of 17.85 would suggest.

Types of Vegetation.—As a rule, the desert type of vegetation prevails (Fig. 4) although there is a wide range from the true xerophytic



Fig. 4. A more or less Typical Area on Part of the Mesa. The fairly flat surface, the sagebrush and cactus of the foreground, the scraggly cedars, and the bushy pinyons back of the cedars make up a typical picture.

type to the highly mesophytic, depending largely on seepage or on the situation of the plant relative to exposure to wind and sun. Along the Mancos River, of course, are cottonwoods, willows, and a general stream vegetation. The Montezuma Valley is rather bare of vegetation except

for the scattered semi-desert type—sagebrush, sun flowers, senecios, etc. There are no grasses in the valley and pasturage is nil. The mesa escarpment on the north and east is covered with vegetation where erosion is not too active, and the kind of plant growth from a highly mesophytic to a highly xerophytic type varies with conditions. The older talus slopes, composed largely of sandstone fragments, are densely covered with pinyons. This tree is rarely, if ever, found in this section on the stiff adobe soil formed from the distintegration of the Mancos shale. An area may thus be mapped by the kind of vegetation which it produces. The narrow steep-walled canyons are in the main bare of vegetation. Where the walls are less steep, the eastward and northward faces have, as a whole, a fair growth; while the southward and westward faces, less protected from the sun and wind, are bare.

The mesa surface is better supplied with vegetation covering. The northern part, because of its greater altitude and also its nearness to the La Platas, has a vegetation very different from that of the southern part. In the north are some excellent pasture lands, especially now since government control prevents overgrazing. This part of the mesa makes an excellent winter range, as the snows rarely are sufficiently heavy for long to hide the season's growth. There are no trees, but a dense expanding growth of oak brush covers large areas and crowds out grasses completely. Judging by the rate of expansion, some observers are quite convinced that it is a relative newcomer to the mesa. In the southern part dense groves of pinyons with some cedars clothe the region. There are no grasses where the pinyon stand is dense, and there is only a very sparse growth in open places.

LOCATION OF AGRICULTURAL LANDS.—On account of the erratic precipitation, land is of little value for agricultural purposes unless so situated that it may be irrigated economically. This, naturally, excludes much of Mancos and most of Montezuma valleys, as well as all mesa surfaces where considerable areas of flat land could be used were there any possibilities of supplying water. The ponding of storm waters has been attempted in both Mancos and Montezuma valleys, by individual ranchers, but the limited storage possibilities and the uncertainty of even this amount makes of it an extremely hazardous investment. Such irrigation reservoirs, because of fill and general lack of upkeep, soon degenerate into mere water holes for live stock. No attempt has been made by modern inhabitants of the region to pond waters on the mesa for purposes of irrigation.

Recently there has been some dry farming in the region, some of which has been fairly successful, but most of it has ended disastrously.

On the mesa few attempts have been made at dry farming, not only because of the sandy character of the soil, but also, and more especially, because the top could be reached only by a steep zigzagging trail before the present Government Road was built. Because of this lack of outlet, parts of the mesa which otherwise might have been used more intensively were given over entirely to the open range. Of course, now that the road is built, the Government has taken over the control, and no development along agricultural lines is permitted. The southern part of the mesa has land flat enough for agriculture, but is too dry even for the most careful of present day dry farming, although in the more favorable years a fairly good crop might be obtained. The northern section is on the whole too rough and too stony, at least for modern cropping, except in a few of the upper canyons such as Prater and Morfield. In a limited area in the upper part of Prater Canyon, Mr. Prater for a number of years in succession has raised excellent crops without the aid of irrigation. This valley, however, is aggraded and, lying several hundred feet below the general surface level, receives considerable seepage. Probably the most vital factor is that the valley is thoroughly protected from the hot drying winds. Many other limited areas within the canyons even farther to the south thus could be utilized were the work done wholly by hand.

The Montezuma Valley to the east and south of Cortez produces only a few drouth resisting plants naturally. There are no natural grasses, and crops grow in the lowland only when well irrigated. However, dry ranches have sprung up all along the northern escarpment of the mesa with more or less success, usually with less. Here the rainfall is slightly heavier, there is more slope wash, and also the hot, drying winds seem to be less effective. In the main, such pioneers lead a precarious existence, entirely at the mercy of the distribution of the rainfall. In moister years such men may raise as good crops as are found on irrigated lands, but in the drier years there may not be sufficient moisture even to sprout the seed of the spring planting, and the land lies barren the entire year. A number of such dry ranches were taken up, fenced, and small buildings put up, only to be abandoned later. In some instances the abandoned homestead has been taken up again by some newcomer who had sufficient faith that under his care crops would grow. Some such optimists, hoping against hope, exist on from year to year, others after a few years give up in despair, leaving their handiwork as a mute testimony of the inexorableness of nature. Slightly better conditions prevail in the lower Mancos Valley, where more or less successful attempts have been made in dry farming also.

In the Montezuma Valley east and south of Cortez some of the available land is under irrigated agriculture. The water is supplied from reservoirs on the Dolores Plateau filled from the run off of winter and spring rains. The reservoirs are limited, and there is usually a scarcity of water in late summer. However, early maturing crops, such as alfalfa, wheat, oats, and potatoes, are grown chiefly. That part of Montezuma County north of Cortez with more water is rapidly becoming an important center for fruit growing. Water, however, is the limiting factor in the development of this valley, and, since the impounding of waters is not only costly and in the main unsatisfactory for other reasons, the greater part of the valley will not be developed for many years to come.

The Mancos Valley is well supplied with water during the spring and early summer from the melting snows of the La Platas, but during the late summer there is not sufficient water to supply all the lands suitable otherwise for irrigation. This land supports at present a fairly dense population of fairly successful ranchers. These ranchers in turn support the prosperous little town of Mancos. Alfalfa is the main crop. Oats is the leading cereal, although some barley and wheat are grown also. Fruits and vegetables do well, but receive scant attention, for too much work is required for the returns in a young country where satisfaction, comfort, or convenience are so lightly regarded.

Throughout the region the soils on the average are fertile, as shown by the luxuriant growths wherever and whenever there is sufficient moisture. In the Montezuma Valley about Cortez the soil is largely residual from the Mancos shale and, like all adobes, most difficult to work except under proper moisture conditions. Where the soil contains enough sand, as that produced by sheet wash from the escarpment, the soil works easily and responds readily to proper cultivation. The soil of the several terraces covering the agricultural section of the Mancos Valley is mostly a silty loam, easily worked and very fertile. In some years in the vicinity of Mancos, excellent crops are grown with only one good irrigation after planting; while in other years water has to be put upon the crops a number of times.

The agricultural development of the region as a whole is not great, chiefly on account of poor transportation facilities. The Denver and Rio Grande Southern Railway, a narrow gauge, offers poor service. The movement of commodities is extremely slow and uncertain. Rates, necessarily, are very high on account of the big initial cost of building and the upkeep. The grades are steep, the road bed in places fre-

quently torn out by floods of spring and summer, and the tracks kept open in winter from the heavy snows on higher areas only with the greatest difficulty.

THE PRODUCTS OF THE REGION.—The products of the region are limited by the transportation conditions. With the present freight conditions, the only industry likely to thrive in excess of local consumption is grazing. With high prices of meats, this industry is thriving; with low prices times are hard. Many ranchers are finding it more profitable to combine the stock range and the agricultural lands, the one to supply the raw material, the live stock, and the other to furnish the means to fatten the stock from the range for the market. From this standpoint, the stock industry is rapidly undergoing a complete change. Few owners depend entirely on the winter range for cattle or upon the general market to supply the feed. The range stock, for the most part, is now fed during the winter so that with a few months of grass they go to the market in good condition. The future of the region unquestionably lies in the growing of livestock on the open range and on land too rough for cultivation, properly housed and fed during the winter, as well as an intelligent feeding of grain and alfalfa before going to market. (Figs. 11 and 12.) Shiftless cattlemen who have not outgrown the old idea that a certain percentage of winter loss of live stock through cold and lack of food is to be expected are rapidly being eliminated by the survival of those who not only feed their stock in winter, but who also grow the produce they feed. With a little expense in seeding grassless areas and a little more intelligent care the capacity of cattle ranges of the region could be increased many fold and all the agricultural products easily and most profitably marketed.

GEOLOGIC PROCESSES AND RESULTS.—In a semi-arid country of this type many geologic processes are more active than in more humid regions. Such is the case in the erosion of the mesa by both wind and water. To those acquainted only with conditions in humid regions, the stupendous amount of erosion here does not seem to have been possible under rainfall conditions similar to those of today. When this concept is coupled with a knowledge of the great number of ruins on the mesa and the great number of people who, seemingly, once thrived here, the conviction becomes very strong that the rainfall conditions have changed tremendously. Although there may have been periods of greater rainfall in the past than at present, yet all the erosional features of the mesa may be explained without recourse to



Fig. 11. Sheep belonging to the Indians grazing in the Montezuma Valley. Although the grazing possibilities seem to be nil, yet the flocks are generally in fine condition.



Fig. 12. Navajo Indians driving a herd of "cayuses" through the Mancos Valley. The Mesa Escarpment is in the distance.

marked climatic changes. The canyons, cliffs, and escarpment are the expressions of the normal erosional processes by wind and water.

Wind Work.—The work of the wind, although a tremendous erosional factor, is more important, perhaps, than that of running water; yet the results are less strikingly in evidence and the topographical effects less. The amount of material carried from the plateau by the wind must be tremendous, undoubtedly the chief factor in the general lowering of the plateau; yet the work is so masked by the work of running water that it is possible to speak of it in the most generalized terms. During the greater part of the year the earth particles are dry and light and the winds strong; the result is manifest in the clouds of dust passing over the plateau. On the mesa many areas are swept bare to the rock; or a clump of grass or a bush has had all the soil at its base swept away except that which it immediately protects. Trails may be worn a foot or more below the general surface.

Upon the canyon walls the effect of the wind work is much more effective than upon the top mesa surface. Even ordinary gusts of wind bring up over the edge of the brink large quantities of material, only to be rolled back again or to be moved elsewhere a little later by another gust. Unbelievably large pieces are rolled from ledges and recesses. Most of the recesses are kept clean of the finer weathered debris and even made larger by actual cutting. The wind is the only agency in moving the material from the recesses and thus enlarging them, as the overhanging bluffs protect the caverns from any rain wash. The use to which these caverns were put by the Cliff-dweller is abundant evidence that water had no part in the making of the deeper recesses, for some of them extend as much as fifty feet or more into the canyon wall.

On the western and northern escarpments wind erosion probably is more active than anywhere else in the region. Here the slopes are composed largely of the soft Mancos shales which weather very easily. The shale is exceptionally susceptible to changes in moisture conditions. Fresh pieces laid out to dry will break up into innumerable small pieces under the influence of the sun, and, conversely, dry pieces after a rain, upon drying again, will be found to have crumbled to dust like a piece of air-slaked lime. The constant rustle of particles on these slopes on a windy day attest to the power of the wind as a most important fact in cliff recession. Indeed, much of the stripping so characteristic of the plateau region has been accomplished by wind as the major factor. It is the feeling of the writer that the work of the wind as an active agent of erosion has been much underestimated.

in geologic processes, for nearly all geologists are native to humid regions and, except perhaps for an occasional visit, actual desert conditions are either partly or wholly unknown to them.

Work of Streams.—A study of the topographic map of the Park cannot fail to impress one with the amount of material which must have been removed by running water. However much was done by wind, the work done by running water in canyon cutting has been tremendous. The magnificent Grand Canyon of the Colorado in Arizona is so overpowering in its immensity that the average mind does not grasp the full significance of running water; but here, with many canyons less overpowering and readily encompassed by the eye, the whole seems more like an open book and leads one to assent to Newberry's²⁹ statement that here is the best place to gain a conception of the enormous amount of erosion on the plateau. Strata to the depth of 1000 to 2000 feet have been removed on every hand, and over extensive territories cubic miles of material have been removed from the top,³⁰ and the interior has been eaten out to the degree of making the canyon the dominant element in the topography. Canyons of a thousand feet are within a stone's throw of each other and in some cases so close that, as the canyon has widened, it has removed the mesa surface intervening and there is only a low divide between them. Many small intercanyon areas have thus been entirely isolated from the surrounding territory and stand out prominently from the canyons below as flat-topped mountains.

Factors in Erosion in the Region.—The great amount and character of the erosion in this area is attributable to a combination of conditions. One of the most prominent of these conditions is the extremely variable semi-arid rainfall. The mesa, as has already been stated, lies on the borderline of arid and humid climates, the line separating the two shifting according to the amount of the extremely variable precipitation of each year, giving the region an extremely arid climate

²⁹ Dr. Newberry was the pioneer in the scientific explorations of the plateaus. His investigations in 1857 covered the area south of the Grand Canyon, and in 1858 he made the trip from Sante Fe, New Mexico, to the Grand and Green Rivers, encircling the mesa. His insight into the region is remarkable, for he not only saw the general outline of the history of the plateau as a whole, but also appreciated fully the enormous work done in the region by the erosive power of running water. The mesa Verde taught him the lesson more fully than the Grand Canyon. He says: "To obtain a great conception of the enormous denudation which the Colorado Plateau has suffered, no better point of view could possibly be selected than the summit of the Mesa Verde." (Macomb Expedition of 1859, p. 85.)

³⁰ "The area of maximum denudation is from 13,000 to 15,000 square miles and the thickness of strata removed from it was about 10,000 feet." Dutton, *The Tertiary History of the Grand Canyon District* (1882), p. 60.

for one year with rainfall near the zero mark, and then again giving the region not many years hence a distinctly humid climate with the precipitation over 25 inches. Under such conditions vegetation cannot become a protective factor which it is in most parts of the world where the precipitation is over twenty-five inches per annum. The intensity of water erosion is, therefore, far greater than the average precipitation would seem to indicate.

This great variation in the annual precipitation has a tendency to increase the amount of erosion over what it would be if the rainfall each year more nearly approached the mean. Since the kind of vegetation is determined by the driest years and not by the mean precipitation for a series of years, with a rainfall of less than ten inches in certain years, only vegetation with special provision for resisting drouths can survive, and such a vegetation has little value as a protective covering. Nor under these conditions is there an accumulation of humus to prevent rapid run off. The occasional heavy annual precipitation in this type of region does not increase the value of vegetation as a protective covering, but, on the contrary, produces a degree of erosion which is far in excess of the normal for either a humid under plant protection or an arid climate where each annual precipitation is more nearly that of the mean. Favorable erosion conditions are still further enhanced because the large part of the rain falls during the latter part of the growing season when most plants are dead and offer the least protection to soil cover. What is more, the major part of the rainfall of the entire growing season may come in a single month, or, as it sometimes occurs, may be concentrated chiefly into a single shower. These infrequent and violent downpours lead to a minimum of plant protection and give a maximum efficiency to the running water. The possibilities for erosion under such conditions are many times what the mean rainfall would seem to indicate, and it seems hardly necessary, as is so frequently done, to postulate for the past greater rainfall to account for the unusual amount of erosion everywhere in evidence throughout the region.²¹

A second important factor in the nature and the amount of erosion is the distribution and character of the rock formations. Although the entire mesa is capped by sandstone, and it is into this that the numerous canyons 800 to 1000 feet deep have been cut, only along the escarpment on the north and northeast and along the upper Mancos Canyon is the underlying shale exposed. Since the sandstone is much more resistant than the soft, friable shale underneath, a steep escarp-

²¹ Atwood, W. W., *Annals Assoc. of Am. Geographers*, I, 100.

ment, often with overhanging cliffs, is maintained, though no permanent stream on the north is present to carry away the talus. The soft shale and the more resistant capping make almost ideal conditions for cliff recession, a characteristic manner in which erosion takes place throughout the entire Plateau Province. As the shale at the base is carried away by the wind and the occasional downpour, and the sandstone undercut, there is a slumping off of huge masses of the latter and the cliff has receded just so much mesaward. This cliff recession and the removal of the soft shale is relatively very rapid compared to the removal by erosion of the fallen heaps of sandstone, some of which are now several miles from the edge of the cliff.

The Rocks as Factors in Erosion Forms.—The sandstone series is in itself a natural cliff former, for it consists of a succession of alternating more resistant sandstones and less resistant shales. Although there is a great local variation, there are in the main two great massive series separated by more easily weathered carbonaceous shales and thin bedded sandstones.³² They are not equally massive everywhere, and, as a result, the cliff feature is not everywhere equally prominent. The cliff feature is most prominent in the south central and southeastern part of the mesa where this series is unusually massive with single beds from fifty to seventy-five feet thick. This same massiveness exists to the east of this region in the Red Mesa and to a slightly less degree in the southern part of the La Plata quadrangle. This massive bed, to a large degree, controls the topography over an enormous area.

The character of this Upper Escarpment series is the vital factor in the topography. This is true even where the massive layer is not immediately at the surface as in the southeastern part where along the canyons it produces a vertical scarp, which is so abrupt that crossing a canyon is impossible except under especially favorable circumstances. Such canyons are locally known as "rim rocked." Where the massiveness of this series is replaced by a thin-bedded series, there

³² This series named the Mesa Verde Sandstone by Holmes (Ninth Ann. Rep. U. S. Geol. and Geogr. Surv. Terr., 1875, p. 244) was divided by him into the "Upper Escarpment Sandstone," a very massive sandstone approximately 190 feet thick; the Middle Coal Group, approximately 800 feet thick, made up of thin-bedded, friable sandstones, shaly beds, and a few coal beds; and the "Lower Escarpment Sandstone" also a massive series of about 120 feet thick. For a more recent classification see A. J. Collier; Bull. 691, U. S. G. S., p. 296. Below this sandstone group lies the Mancos shale with a maximum thickness of about 1200 feet. This is a highly carbonaceous shale weathering with unusual ease. Below the Mancos shale lies the Dakota sandstone outcropping a little to the north of the mesa over wide areas on the Dolores Plateau. All of these formations belong to the lower Cretaceous Period. For further information relative to these formations see folios of the Geol. Atlas of the United States: La Plata 60; Telluride 57; Ouray 153; Silverton 120.

are few flat stretches, and the intercanyon areas are well rounded, giving an entirely different aspect to the topography. It should be noted also, however, that much, if not most, of the Upper Escarpment series in the north has been removed by erosion. This being the case, the topography in the north has been produced in part on the thinly bedded Middle Coal Group below the Upper Escarpment Sandstone. The difference in the topography may be noted quite readily on the topographic map, and the line separating the two regions is so well marked that even cattlemen designate it as "the break." The Lower Escarpment Sandstone is too low in the canyons on the average to be very effective in the control of the character of the canyon. However, along the northern escarpment, it forms the protective covering for the softer shale below and produces here a verticality of the scarp such as at Point Lookout, similar to the effects of the upper series upon the rim-rocked canyons in the southern part.

The Dip of the Rock as a Factor.—A third important factor in the kind and quantity of the erosion is the dip of the rock in relation to the surface and the stream gradients. The general slope of the mesa surface is to the south, with a gradient averaging about 125 to 150 feet to the mile. The strata also dip to the south about 150 to 175 feet, but the dip is slightly greater than the general surface slope and, naturally, there must be a surface truncation of the beds. The stream gradients in the lower parts of the canyons are less than either the dip of the rock or the general surface slope. This means that a stream like the Mancos River in its course south across the mesa gradually rises higher and higher in the geological formations. The Mancos is an especially good example of this sort, for in its upper course it has cut through the entire sandstone series and is developing a wide open valley on the softer shale below. In its lower course near Trail Canyon it enters the sandstone series and continues in this for many miles in a narrow canyon, later cutting through the sandstone into the shale series to the southwest of the Park. Similarly, Morfield and Prater Canyons, in their upper courses, have been cut through the sandstone and into the shale. The result here is broad open valleys in the north within canyon walls which are very steep in part, especially where cut through the Lower Escarpment series; while in the south, where the canyons are wholly in the sandstone, the canyons are narrow and rim rocked.

This relation of the stream gradient and the rock dip affects also the erosion in other ways. With this combination the down cutting is directed always toward the upturned edges of the strata. With the

alternation of more resistant and less resistant layers, many of the more resistant layers are removed chiefly by the breaking out of large blocks and not so much by the common method of down cutting by the wear of pebbles. Erosion under such conditions is very much more rapid, other things being equal, than should the stream enter from younger into older beds. Under the local conditions the gradient of the stream bed remains fairly uniform and there are no waterfalls and few rapids. The stream is narrowest where it is cutting a resistant layer and widens out above and below. Since the cutting front of a resistant layer migrates down stream, the widest part of the canyon is in the upper reaches and as times goes on migrates down stream also. The Mancos with its wide upper and narrow lower canyon is an excellent example of this, for the farther south within the mesa the narrower is its course.

The Effect of Rapid Rise and Fall.—Another factor in erosion and deposition is the extremely rapid rise and fall of waters in stream beds in arid regions. The velocity of a stream depends more upon the gradient of the water surface than upon that of the stream bed. Where the flood comes in a wave, the gradient of the water surface is much greater than where the flood comes gradually. Consequently, the erosive power in this advancing wave is enormously greater than where the rise of water is gradual. Similarly, where the waters fall rapidly, the hindmost waters may be depositing because the surface gradient of the water is greatly reduced or possibly eliminated entirely; on the other hand, where the waters subside slowly, the surface level of the hindmost waters may not be changed much whether in high or low flood stage. This condition is enhanced by the fact that for the most part floods in arid regions are from rains which have fallen up farther, nearer the source of the stream and not along the stream where the flood occurs. This fact during the time of rising waters makes the erosive and carrying power of the water much greater than if the high water were the result of heavy rains farther down the stream or from tributary streams. Similarly, deposits will be made when the river is falling that will be picked up later when the stream is much more sluggish.

At the present time water erosion in the uplands is confined almost altogether to sheet wash. On a comparatively flat sandy surface, with a slope of 100 to 150 feet to the mile, as is the case in the southern part, the water falling in brief torrents is soon overloaded and then erosion, of course, is nil. In regions of this type the water is soon overloaded, because of the abundant loose debris at the surface and

because of the rapidity with which it sinks into the ground. Even where it becomes concentrated somewhat in slight draws, the velocity is not sufficiently increased to become again an erosive agent before it is again overloaded and its erosive power once more becomes nil. Only where the water drops over the rim-rock and where it strikes at the bottom can there be much erosion other than sheet wash. Even in the north, where the surface slopes are much steeper, there is little gullying and the bottoms of the canyons show a great deal of fill.

The Mesa Being Reduced in Area.—The mesa is constantly being reduced in size by the gradual stripping on the north and west of the formation, which causes it to stand out above the Dolores Plateau to the north. Because of the dip and character of the rock, and the greater rainfall here, the erosion is directed at all times against the base of the mesa. There is a tendency to undercutting, and along the northern edge a steep escarpment is maintained. This escarpment in the main is vertical in the upper parts or even overhanging for 500 to 1000 feet. The rest of the escarpment may well be considered steep talus slopes of 500 to 1000 feet more. As the lower material is removed, the vertical face above is weakened, big masses slump, and thus the escarpment migrates to the south, gradually cutting more and more off the upper canyons along the entire mesa front.

There can be little doubt that formerly the mesa surface reached much farther to the north and northeast, extending over the Dolores Plateau to the north and probably over the San Juan region to the north and east; and that after the doming of the La Platas in Tertiary times active stripping began.²² The higher areas, because of greater precipitation and steeper stream gradients, suffered greater erosion than the region farther out, and the softer formations were readily stripped from the area. This stripping continued from the mountains plateauward, thus gradually removing the upper parts of the valleys, and causing the plateau escarpment to migrate away from the mountains.

Origin of Physiographic Features.—The principal features of the mesa, therefore, are purely products of its erosional history. Its former great extension to the north and to the northeast served to bring sufficient water for the development of an unusual system of deep canyons. The canyon cutting gradually became less and less marked with the decrease of running water, until at the present time there is not enough water to carry away the slight wash from

²² Cross, *La Plata Folio*, U. S. G. S., pp. 4-10.

the canyon walls. Canyon erosion, therefore, practically has ceased throughout the entire mesa because the water supply from the north has been entirely cut off. On the other hand, erosion by sheet wash and cliff recession is extremely active. Unquestionably, a large part of the mesa has already been removed, and with it the upper ends of the main canyons, leaving the truncated ends as records of a condition long since past.

LEADING ENVIRONMENTAL FACTORS.—Into this region many centuries ago came the wandering Indian tribes that were destined to give the world a new culture. The reason for selecting this barren region for a home is not clear; but quite surely they came because they hoped to better their condition and not because they were more ambitious than their neighbors. They brought little knowledge that was helpful to them in their new home, and practically their entire cultural advancement was gained in the new environment. With the solving of their problems they gradually built up a culture which is as far removed from that of the European as though it had developed on another planet. Only a few of the major relationships that made this evolution possible can be suggested in this brief discussion.

The Pueblo Country.—Our Southwest has become known as the "Pueblo country," and rightly so, for here the Pueblo village Indian reached his highest development and here he is still found little touched by world movements. Only in the more favorable sections has the white man encroached upon his territory; while in others he is still as much in control as were his pre-Columbian ancestors, in whose pueblos, in some cases, he is still living. Many of the pueblos, like the cliff-dwellings, long since abandoned, are in such states of disrepair that even a semblance of restoration is impossible. Of the minor antiquities many of those of value have been carried away by "pot-hunters" and are now in private collections largely valueless to science because of the lack of record of where and under what conditions found. Much more of the material than ever was preserved has been irreparably damaged or even lost due to the ignorance or carelessness of the vandals. The sad part of it is that this looting is still going on today, for many of the more hopeful prospects are open to anyone who has an inclination to dig. Many valuable treasures thus are being lost annually to science, and the interpretation of others still to be unearthed is made correspondingly more difficult.

Pre-Columbian Culture Advanced.—The relatively little work done, however, in this region brings out clearly the high degree of development of this pre-Columbian culture. Manifestly, natural con-

ditions have changed radically, or else the physical environment which was favorable for the earlier development was not favorable for the latter. That the natural conditions have not changed vitally is generally agreed upon by research students in various fields. Neither does a change in natural conditions seem necessary to explain the degeneracy and even disappearance of the Cliff-dwellers. Why an environment should be so favorable for the early development and so unfavorable for the later and higher cultural life is not easy to explain. Perhaps the adjustment was so complete that the variation, even of what seems to us now as a very minor factor, was sufficient to upset the entire balance. What is probably the more likely true is that certain factors in the ethnic environment, such as jealousies and dissensions, warfare, superstitions, diseases, and the like, started the toboggan, and the diseases and hardships and enslavement brought by the Spaniard did the rest.

In the rise of this culture many factors, necessarily, must have contributed. Some of them, however, stand out more prominently than others. Probably no other factor has been so vital in the cultural evolution of these people as the one of isolation. They were isolated not only from far distant tribes by almost impassable food barriers, but also from other groups of their own kind by barriers which limited their interchange of ideas sufficiently to show striking differences in the major and minor antiquities as we now know them. This local isolation made the distinctive group life possible. Thus, whether in the study of pottery, clothing, masonry, or other cultural elements, these differences come to the fore. Along the river valleys, which were the real and, in most cases, the only routes of travel, there is a blending of one into the other. In fact, as was noted in early studies, the culture may be divided according to the large river basins, such as the Rio Grande, San Juan, Little Colorado, and the Gila. These basins hold also the bulk of the living representatives, as well as the major antiquities. Since the present inhabitants do not all speak the same language nor even the same dialect, Brinton comes to the conclusion "that the Pueblo civilization is not due to any one unusually gifted lineage, but is a local product developed by independent tribes by the natural facilities offered by the locality."²⁴

Effects of Isolation.—Local isolation meant also local concentration. With an inevitable increase in numbers and with the scant water

²⁴ Brinton, "The American Race," p. 116.

and food supplies already stretched to the limit, what was to be done?²⁵ Whatever their solution, this necessarily was a question for the whole group to work out. There could be no individual independence and we know there was none. Their isolation also intensified the severity of conditions in bad years, and their only salvation was in united action. When there were good years, the stronger and the more unified the group, the more likely was it that their crops could be held against raiding parties from neighboring groups less favorably situated. What is more natural than that they should build large communal houses, some of a thousand rooms or more, and large communal places for the storing of food and water?

Great Dependence on Water.—In the life which the Indian was forced to live, undoubtedly, water was his greatest problem. This constant and never ceasing need of water, also, was probably the greatest factor in his development. Water in this region of scarcity held them in groups to the land even more than growing crops. Around one good spring or waterhole many clans could be grouped. Food could be carried farther and easier than water, and a constant supply of water was more essential than a constant supply of food. As a result, the Indian advanced farther along the lines pertaining to water than he did along any other. He learned to spin and weave, to pile stones and bind them together with mud, even to dress and polish them; yet in all these there is no advance comparable to his skill in ceramics or even in the working out of the principles of irrigation.

Skill in Ceramics.—The skill developed in the making of pottery was most remarkable in view of the fact that the wheel never was used.²⁶ In spite of this, many vessels have been found so nearly perfect that the eye cannot detect any irregularity of shape. The Pueblo not only knew how to make the vessels, but also to decorate them, and he did this with no mean appreciation of the beautiful. His versatility along this line is made very evident in the great variety of forms, as well as the many methods used to get the desired effect. Some vessels are so large with such thin walls that it is not clear to us what method was used to keep them from collapsing during the process of firing. But he did not limit himself to pottery alone, for scores of other clay objects have been found. Not only did the scarcity

²⁵ For a similar set of conditions see the illuminating discussion by Bowman, "The Desert as a Geographical Laboratory," p. 5, and Ch. VI, Population Groups of the Nitrate Desert, in his book, "Desert Trails of Atacama," Special Pub'n. No. 5, Am. Geogr. Soc.

²⁶ Wissler, op. cit. p. 69.

of water start him along this path of advancement, but the conditions were such that this type of work was ever kept in the foreground. The work was done over and over again by the same person; while in the case of building, this was done on such rare occasions that the experience never came to one man probably more than once in a life time. The advancement in the ceramic art, however, was limited very definitely by the geologic conditions. The artist was limited by the kind of clays he had to deal with, and, although he tried many mixtures in order to improve his work; yet the poor grade of his clays in general limited the artistic quality of his product. An arid region, as is well known, is not a likely one in which to find high grade moulding clays.

As an Irrigation Farmer.—The Indian developed also a great deal of skill in the handling of irrigating water. We think of desert peoples, commonly, as nomads who use their flocks to concentrate the sparse vegetation for them. Here the people were unusually immobile for they had no herds to follow and little occasion to move except on raids, perhaps, when hunger forced them. There were no grazing animals to domesticate, and, had there been, it is extremely doubtful if in this region grazing could have been depended on. Conditions were such that small areas had to produce relatively large amounts of food. He had brought with him from the outside world his maize and forthwith learned to pond the storm water, and, when the water had soaked away, to plant his seed in the well moistened soil. He also learned to lead the stream waters to his fields, and he did this on such a large scale that in the Salt River Valley engineers used sections of ancient canals at a considerable saving in the construction costs of the modern system. In the Mesa Verde irrigation was practiced, but the systems were all on a small scale. At Aztec, New Mexico, on the La Plata, some of the ditches can still be traced for several miles. The most extensive irrigation, as present evidences go, was in the Salt River Valley, now watered again by the waters impounded by the Roosevelt dam.³⁷

Area of Crop Lands.—Next to water, good crop land was the most important factor in the Indian's advancement. Whatever the reason

³⁷ About two miles west of Florence (Arizona) on the north side of the Mesa is a stretch of land through which another of the large irrigating canals was cut and where for several hundred yards one can ride on horseback in the canal, which is yet so deep one cannot look over its banks on either side when sitting on his horse. Even attempts were made to store water in certain sections in Animas Valley, N. M., a gigantic earthwork or dam, has been built 5.5 miles long and twenty-two to twenty-four feet high. See Gaillard, D.D., *American Anthropologist*, Vol. IX, (First Series), pp. 311-313, "Gigantic Earthwork in New Mexico."

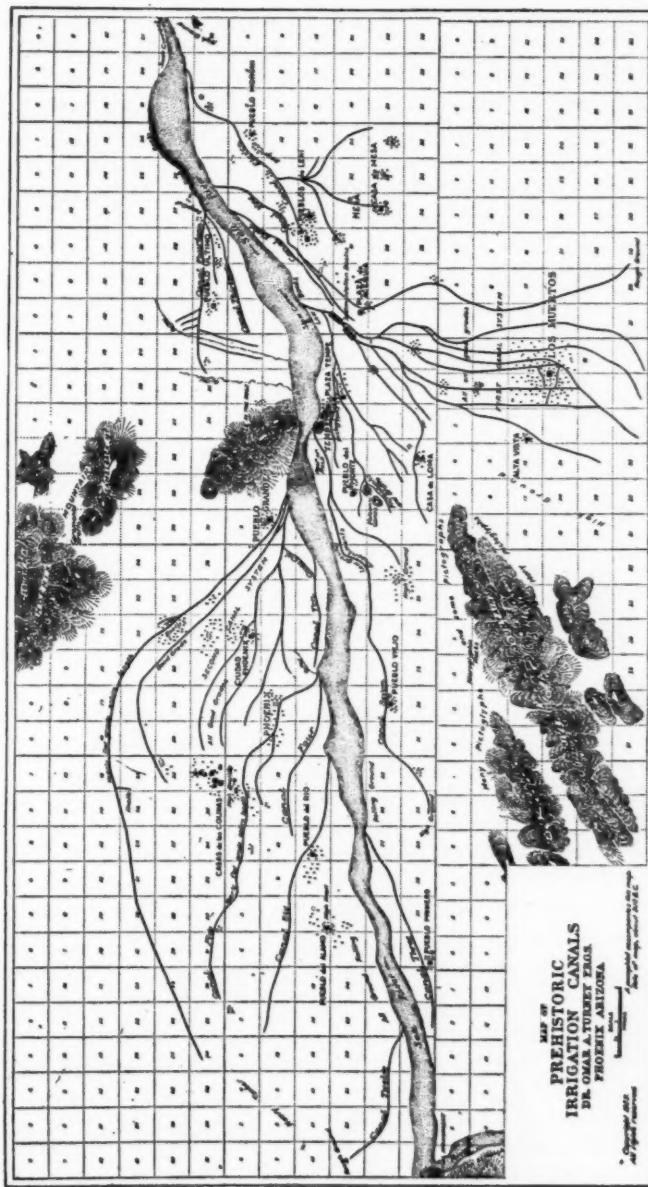


FIG. 13. Map of Prehistoric Irrigation Canals in the Salt River Valley in the Vicinity of Phoenix. The data shown on the map is the result of many years' work and has been prepared with great care. Permission to use the map (copyrighted 1922) has been granted the author by the courtesy of Dr. Omar A. Turney.

for his presence in this inhospitable region, the facts remains that, until the arrival of the Spaniard with his domesticated animals, he had to depend practically altogether on crops for his subsistence. Whether the better endowed sections were responsible for a more rapid or a higher development cannot be stated, but it may well be that the remarkable ruins of the Mesa Verde represent a culture which owed its greatness to the extensive good crop lands relatively near and to the greater rainfall that this section enjoys. Although the agricultural lands relatively near are not ideal, yet they are of sufficiently high grade to produce good crops. The acreage also is large, and it safely may be stated that the possible Indian crop land is to be counted in thousands of acres, and, if the lands of the Mancos and Montezuma valleys be added, then the area will be increased many fold. So many unknown factors, however, enter into the problem of estimating the available land that the value of such a figure is questionable.

Communistic Society.—Most of the land of the plateau, however, had little value to the Indian without water, and the more elaborate the irrigating system, the more valuable the land became. With such improvements established at great labor costs, he became still more deeply rooted to the soil. With irrigation the favorable food producing areas became still more restricted. Strong communities became possible, and these in turn, through united efforts, made huge irrigation projects possible. Only when there was a strong social organization could such a community survive, and such a strong community government naturally took on a communistic form. It was through communism that the food supply could be kept for the whole group, and it was through communism that a supply could be laid by for the lean years which were inevitable. In the building of storage reservoirs, or irrigation ditches, of water towers, of food storage places, of huge water jars, in fact in every line of activity, it was a community affair, and not that of the individual. And thus the new world developed a highly communistic form of government long before the white man dreamed of such a thing.

The Purity of the Water.—The general lack of water, however, had its particular advantages also. The impurity with which the westerner drinks out of ditches and waterholes is a constant surprise to the easterner accustomed to the dangers which lurk in such places. However, under a hot sun with drying winds, sparse populations, and scanty vegetation, the possibility of water contamination is infinitely reduced. Moreover, with a lack of favorable conditions for the higher forms of life, there is in general also a lack of conditions favorable

for bacterial growth and the propagation and spread of diseases. That there were epidemics in the Pueblo country before the advance of the white man is well known, and that there have been great epidemics since is a matter of history, but such epidemics were looked upon as scourges and not as something to be expected. In the main, they were free from diseases which sap the vitality and take away ambition. Anyone acquainted with the unsanitary conditions of many of the villages must marvel that diseases did not sweep all away. Perhaps that is why so many dwellings and even villages were abandoned and the superstition against occupying a village for the second time arose. The dry air unquestionably was the Indian's ally, his scavenger, and his protector.

Natural Conditions Not Unsanitary.—With sandstone as the underlying rock and with adjacent deep canyons there is no question of proper drainage. The night soil and other refuse matter did not constitute a problem, for it all soon dried to dust. When a rain came, the shower usually was heavy enough to carry the debris over the canyon walls, or, if the water penetrated the sandstone, it became purified before it came out again in seeps or springs. With the general lack of sanitary conditions which evidences show prevailed, it is extremely doubtful if the people could have survived for a considerable length of time had natural conditions been less favorable. Diseases of filth, like typhoid and dysentery, could hardly be expected to make great headway in this type of country.

The traveler in the more arid regions frequently is deceived when he finds dead animals along the way. They look so well preserved that death seems to have come to them only a day or so ago, when in reality they may have died several months before and be only dried hollow shells. Fresh meat hung up in this rarefied air soon becomes so dry on the outside that the blowfly's eggs dry up with the meat. The dead were mummified easily without preservatives, and perhaps to this may be traced the custom of placing the dead upon platforms away from coyotes and where the drying winds would be most effective. In the cliff-dwellings the shallow part of the cavern at the back was given over to the domesticated turkey. In moist climates this would have been attended with serious dangers. Here, though, the dead turkeys, as well as the refuse matter, soon dried up and became relatively harmless.

Water Requirements Low.—To many it seems incredible that the Southwest ever should have been so densely populated as the antiquities seem to indicate with so little water in evidence now. Too many

writers on the Indian, however, think of water only as running water. They do not understand that, except in the larger streams and at flood times, the movement of water is in the sands below the surface. Thus, Alacron does not even mention the mouth of the Gila when he rode up the great Colorado in September, 1540, for the Gila at that season carries little or no surface water.³⁸ Shallow wells dug into such stream beds rarely fail to furnish water, and in the Canyon de Chelley the present Navajos obtain their water in this way.³⁹ The mistake is not to be made that, because the map of a region shows no running water, therefore the region is waterless. In the 30,000 square miles of the San Juan basin, only in the river itself and in a few of the tributaries is there any surface water except in an occasional pool or waterhole. Nevertheless, water has been and is the most important agent in the settlement of the Southwest, also the most immediate cause for strife and disturbance.

It is also to be remembered that the Indian of the Southwest needs very little water. The amount needed for the preparation of food is almost negligible. Even when water is abundant, little is used for the washing of clothes or body. Nor does he need much for drinking purposes. McGee reports that "the Papago Vaquero will ride one, two, or even three days without drinking under a sun so fierce and in an air so dry that the tenderfoot would die in a few hours; and a family of a dozen often confine themselves for weeks to the contents of a single olla daily for drinking and all other purposes."⁴⁰ In too many writings it has been taken for granted that the Indian of the arid plateau needed daily as much water as does the white man.

Food Requirements.—Neither may the problem of food have been as great as we may now think, for the Indian had a wide range of foods, some of which may be entirely unknown to the present day investigator. We know that at present the Indian feeds on many an article which is highly revolting to us⁴¹ and upon a wide variety of foods utterly distasteful to the white man, and he does this in preference to what the white man esteems most highly. Besides, the Cliff-dwellers and the Pueblos were not only agriculturists but hunters as well, as the great number and variety of bones found will testify. From these

³⁸ Bandelier, A. F., Archeological Institute, American Series, III, Part I, p. 18.

³⁹ Mendeleff, Cosmos, American Anthropologist, Vol. VIII, (First Series), pp. 153-174, "Cliff Ruins of the Canon de Chelley."

⁴⁰ McGee, American Anthropologist, Vol. VIII, (First Series), pp. 350-375, "The Beginnings of Agriculture."

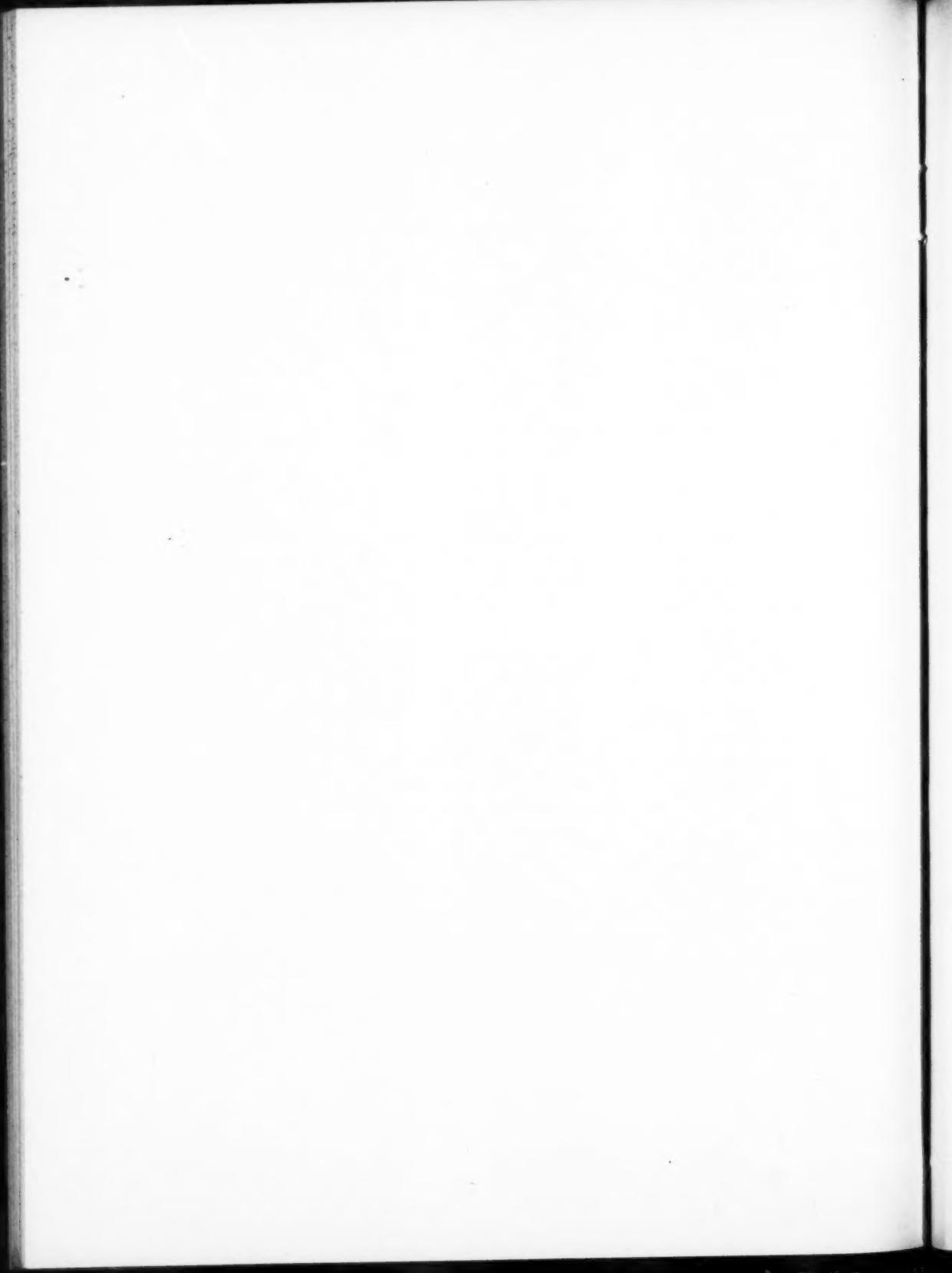
⁴¹ Bandelier, A. F. Archeological Institute, American Series, Pt. I, p. 22, "Investigations among the Indians of the South Western Part of the United States."

same bone heaps it is evident that they were hunters of considerable skill, capturing their quarry whether it was large or small.⁴²

Slow Progress in Architecture.—The housing problem never was as serious as that of food and water, and the art and science of building made relatively little advancement. This is true in spite of the fact that the structures of various kinds stand in the forefront in the public mind. The mediocre advancement made has been accounted for by the fact that the same generation probably never helped to build more than one pueblo or cliff-dwelling, and, since the experience was not recorded outside the building itself, the knowledge gained was largely lost. The house, where possible, was located with reference to the ease with which the builder could obtain material for building. Water, food, and protection also were important factors, but distinctly minor to materials themselves. Water and food could be carried long distances, but not clay and stone. Little planning, however, was done. Even in the larger structures there was little or no preparation in laying of foundations. Cliff-palace is an example in which the walls are laid over angular rocks and loose debris which easily could have been cleared away.

The Struggle for Existence.—In the study of the natural conditions out of which grew this unusual cultural group nothing is more impressive than the fight made against Nature's ways, and how unyielding Nature must have seemed to the Pueblos or Cliff-dwellers in spite of all their ceremonies and superstitious beliefs. Nevertheless, they struggled on, at first successfully, but soon to fail and succumb to the same forces that before had made them grow strong. One can hardly believe that they lost heart after having accomplished so much. Perhaps, they had accomplished all that was possible under the adverse conditions. Perhaps, they were like the camel and the horse, developing rapidly at first, only to succumb later to the same environment that had produced them.

⁴² Fewkes, Bur. of Am. Ethnol., 28th Ann. Rep. (1906-1907), p. 146.



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